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Cooling network design of the ITER thermal shield considering its flow distribution and thermal load

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Thermal Shield (TS) in the ITER tokamak cuts off the radiation heat load from the vacuum vessel/cryostat transferring to the magnets operating at 4.5 K. The TS will be cooled down by 80 K helium gas supplied from the cryoplant. The helium goes through the cooling tubes attached on the TS. The TS consists of a lot of panels, which are to be connected by bolted joints. The panels have their own cooling tube routings and they are connected to the end of cryo-distribution lines by manifold piping. As the composed piping for the TS cooling is complex, the flow distribution is one of the major concerns for the design of TS cooling network. This paper describes the design of TS cooling tube and manifold, taking the flow distribution and the thermal load into account. The TS hydraulic network was modeled in details by a dedicated program. Frictional pressure drop in the pipes and local losses at all piping components in the TS were considered in the model. It was found that coolant flow rates in some panels were insufficient compared with their design values. Two kinds of design modifications were proposed in order to improve the flow distribution in the cooling tubes. Thermal analysis was also performed for the manifold feeder, the surface of which is partly exposed to the warm surface. The helium temperature rise through the manifold feeder due to incident radiation was obtained and its effect on the radiation shielding performance of the TS was evaluated.

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